

Introduction

3,4-Methylenedioxymethamphetamine (MDMA; Ecstasy) is a hallucinogenic, “designer” methamphetamine derivative currently popular with adolescent and young adult populations.

In addition to increased energy and insight, experiences associated with other hallucinogens or stimulants, ecstasy reportedly creates an additional, unique sense of well-being, affection and love [1-3]. This, contrasts with the violence and disruption often associated with alcohol or use of some other drugs. In addition, its historic use as a counseling adjunct has long afforded ecstasy a misleading reputation as a safe or even self-enhancing drug, despite government restrictions and scheduling since 1985 [4-6].

This perception is slowly changing, especially within the medical community, as a growing literature suggests both short and long term toxicity associated with MDMA use. Acute effects of MDMA use include restlessness, anxiety, trismus, hyperthermia, hyponatremia and subsequent cerebral edema, commonly occurring at “raves” or other all-night dance parties where the drug still holds its greatest popularity [7-9]. MDMA may also predispose users to accidents from increased high-risk behavior [10]. Other reported acute effects, including hepatic dysfunction, cardiovascular disturbance, psychosis, coma, and death, are sporadic, and may reflect, at least in part, the frequent impurity of street MDMA and the individual differences in physiologic response [11-12]. Evidence suggesting long term serotonergic neurotoxicity has been well documented in studies of animals ranging from rats to non-human primates [13]. A growing literature offers evidence of chronic serotonergic dysfunction in humans [13], an effect which may be permanent [14]. Direct physiologic evidence of decreased serotonergic activity as well as concordant psychiatric and cognitive effects, such as problems with memory, attention, reasoning, impulse control, and sleep cycles, have been demonstrated [7,13,15-18].

Despite such findings, MDMA has shown a dramatic increase in use over recent years. In the 1998 and 1999 Monitoring the Future study, 10th and 12th grade last-year ecstasy use increased from 3.3% to 4.4% and from 3.6% to 5.6% respectively [19]. This increase appears to have occurred over a period when use of other illicit drugs has remained constant or decreased.

Like other illicit drugs, first exposure and continued use of ecstasy appear to occur more frequently in the adolescent and young adult populations [20-21]. There is evidence that, unlike other drugs, MDMA may be more likely to be first tried in college [20]. In addition, college students are of particular importance since they constitute a wide age group for which life-long habits are established. College provides many students with their first opportunity to both act independently and within a group of peers; it consists of individuals most likely to set cultural norms and public policy in the future; and significantly, it encompasses an age group that has the highest overall incidence of drug use [22].

Despite the increasing popularity of MDMA, there are few epidemiologic data about the type of student who uses ecstasy. The goal of the present study was to quantify, identify and describe ecstasy users.

Methods

The College Sample

The data presented in this paper are based on the 1997 and 1999 Harvard School of Public Health College Alcohol Study (CAS). The CAS surveys a national sample of undergraduate students at U.S. four-year colleges and was conducted in 1993, 1997 and 1999. In 1993, 140 colleges were selected from the American Council on Education’s list of accredited universities using probability proportionate to size sampling for the first survey conducted by the CAS. One-hundred twenty-eight of the original 140 colleges that participated in the 1993 College Alcohol Study were resurveyed in 1997 and 1999. The

same procedure for student sampling and research design was used for each survey year. The details of the sample and research design of the three surveys are published elsewhere [23-25]. In 1999, administrators at each participating college provided a random sample of 225 undergraduates from the total enrollment of full-time students.

We excluded schools from the analyses that failed to meet the minimal criteria for response rate. To be included in the 3-year comparison sample described in this report, a school had to have a response rate of at least 50% in two of the three surveys and a rate of at least 40% in the third. For all 3 survey years, 9 schools were dropped from the analyses leaving 119 schools which met these criteria. Rates of past 30-day ecstasy use of the 119 schools retained in 1999 were identical to the corresponding rates of all 128 schools participating in 1999. Dropping the low-response schools did not change the results of the survey. Similar comparisons for the 1997 and 1993 rates of these schools with those of the total samples in those years also revealed no differences.

The 119 schools are located in 40 states and the District of Columbia, providing a cross-section of higher education in the United States. Over two-thirds of the colleges sampled are public institutions, while less than one-third are private. The schools vary in enrollment size. Less than half of the schools (44%) are large (over 10,000 students), nearly one quarter (23%) is medium size (5,001 to 10,000 students) and one-third (34%) are small (5,000 or fewer students). About two-thirds (71%) are located in an urban or suburban setting and one-third are in small town/rural settings. Sixteen percent are religiously affiliated. Five percent are women-only schools.

The Student Sample

Characteristics of the respondents who attended one of the participating U.S. 4-year colleges were very similar in 1997 (N=14,724) and 1999 (N=14,138). Three of five respondents (60% in 1997 and 61% in 1999) were women. In the U.S., women make up 55% of undergraduates at 4-year institutions [26]. The sample was predominately white (79% in 1997 and 78% in 1999). In the U.S., 78% of undergraduate students at 4-year institutions are white [26]. In each of the two samples, approximately one-quarter of the students were freshmen (24% in 1997 and 23% in 1999), two-fifths of the students were sophomores (22% in 1997 and 22% in 1999), one-quarter were juniors (23% in 1997 and 25% in 1999) and one-third of the students were seniors or 5th year students (31% in 1997 and 30% in 1999).

Owing to the large sample size, relatively small differences between the 1997 and 1999 samples were statistically significant for most demographic characteristics. These demographic differences in gender, race/ethnicity, and age were controlled for in the multiple logistic regression model.

The "Matter of Degree"(MOD) Sample

Another data set provided the opportunity to examine MDMA use rates one year later in the year 2000. At ten colleges located in all regions of the country larger samples of students than in the CAS survey were available. These colleges, all part of the national CAS sample, had been selected to participate in a comprehensive alcohol abuse intervention program, a "Matter of Degree" (MOD). The schools were selected because of their high rates of binge drinking in 1993. Two of the colleges were in the northeast, 4 in the south, 3 in the north central and one in the west. Nine were public, and one private. Seven of the schools were large (over 10,000 students), 2 were medium size (5,001 to 10,000 students) and one was small (5,000 or fewer students). Seven were located in an urban or suburban setting and 3 in small town/rural settings.

Administrators at each of the ten schools provided a random sample of 675 undergraduates, 3 times as many as those in the CAS, from the total enrollment of full-time students. The same procedure for student sampling and research design used in the CAS survey was applied to the MOD study.

The Questionnaire and Measures

The self-administered instruments in 1999 repeated the same questions used in 1997 about illicit drug use, alcohol and tobacco, as well as student lifestyle, demographic and background characteristics. These questions were based on those used previously in national or other large-scale studies [27-28].

The list of drugs and selection of prevalence periods were chosen to correspond with those used in the Monitoring the Future Survey series whenever possible [19]. Ecstasy was included in the 1997 and 1999 surveys, but not in 1993 [29-30]. To assess ecstasy use, respondents were asked when, if ever, they had used ecstasy. Response options were “never used”, “used, but not in the past 12 months”, “used, but not in the past 30 days”, or “used in the past 30 days”. A parallel question asked about use of cigarettes and marijuana.

Binge drinking was defined as the consumption of 5 or more drinks in a row for men and 4 or more drinks in a row for women during the 2 weeks prior to the survey, as previously described [23-25]. Colleges were divided into categories based on their aggregate levels of binge drinking: high binge campuses (more than 50% binge drinkers), medium binge campuses (36-50% binge drinkers), and low binge campuses (35% or fewer binge drinkers).

Survey Procedures and Response Rate

In both 1997 and 1999, questionnaires were initially mailed to students beginning at the end of February. Three separate mailings were sent within at least a three-week period; first a questionnaire was sent, then a reminder postcard, followed by a second questionnaire. Mailings were timed to avoid the period immediately preceding and following Spring Break, so that students would be responding to behavior during a time when they were on campus. Student participation was voluntary and anonymous. To encourage participation, students were offered the following chances at cash awards: one \$1,000 award to a student whose name was drawn from among students responding within 1 week, and one \$500 award and ten \$100 awards to students selected from all those who responded.

Questionnaires were mailed to students at the participating schools after eliminating ineligible students with incorrect addresses, withdrawal from school, or leaves of absence. Response rates varied among the 119 colleges that participated in the 1997 and 1999 surveys. In the 1997 sample, response rates varied from 40% to 88%, with an overall response rate of 60%. The response rate for the 1999 sample varied from 40% to 83%, with an overall response rate of 60%.

In order to examine potential bias introduced by non-responders, several procedures were used. First, responses of students who responded early versus those who responded late were compared. There was no statistically significant difference in rates of past year ecstasy use between students who responded early vs. late in 1999 (4.6% vs. 5.4%; $p=0.06$). In addition, a short form of the questionnaire including a question about other substance uses was sent to students in 1997 who did not respond to the questionnaire. There was no significant difference in rates of alcohol and cigarette use for those that answered the short survey compared to those that responded to the entire questionnaire.

Data Analysis

All statistical analyses were carried out using SAS version 6.12 [31]. When controlled for each student and college characteristic, differences in prevalence of ecstasy use between 1997 and 1999 were compared by 2 × 2 Chi-square analysis. Percent changes for college and student characteristics were presented for ecstasy use to demonstrate the prevalence change over time. Because rate of ecstasy use was small and the sample sizes were large (over 14,000 students in each year), changes in ecstasy use were considered statistically significant if the *p*-value for the Chi-square analysis was less than the .001 level.

Logistic regression was applied to modeling behavioral and lifestyle factors associated with past year ecstasy use. Factors that were significantly associated with past year ecstasy use in univariate analysis were included in the final model. The final model also included gender, age, marital status, race, region, and school binge level, but the results for these demographic and college characteristics were not reported. The response rate of each school was also included in the model as a college-level covariate to control its potential confounding with the type of housing, and/or with other student and school characteristics. We used the generalized estimating equations (GEE) approach to fitting the logistic regression models [32-33] in order to appropriately handle the clustered outcomes arising in our sampling scheme. Because the results were consistent with the stratified Chi-square analysis they are not presented. The odds ratio point estimates obtained from the GEE method were almost identical to those from ordinary logistic regression estimation, while the standard errors of the odds ratios associated with the college characteristics were slightly greater. Hence, the conservative GEE based results are reported.

Results

Change in Past Year Prevalence Ecstasy Use Among Demographic Subgroups (Table 1)

There was a significant increase from 1997 to 1999 in past year ecstasy use among U.S. 4- year college students (from 2.8% to 4.7%, *p*<0.001). This rise held regardless of gender, year in school, and member of fraternity/sorority. However, the rise from 1997 to 1999 was not significant at minority ethnical groups, students older than 24 years, married students, residents in fraternity/sorority house. The lack of statistical significance for those subgroups may be owing to small cell size. A sharp increase of ecstasy use was found among sophomores, and dormitory residents.

Change in Prevalence of Past year Ecstasy Use Among Types of Colleges (Table 2)

Changes in past year ecstasy use among the different types of colleges are presented in Table 2. The prevalence of past year ecstasy use increased significantly from 1997 to 1999 in every college subgroup except for non-competitive schools.

A sharp increase was reported among small size schools (less than 5,000), highly competitive schools, Northeastern schools, women-only schools, private schools, and high binge campuses.

We conducted a logistic regression to test if the rise of ecstasy use from 1997 to 1999 is consistent even when controlled for some important student and college characteristics. A logistic regression revealed that students were 1.4 times more likely to be ecstasy users in 1999 than in 1997, even when age, gender, race, fraternity/sorority member, region of the country, and school response rate were controlled (Adjusted OR = 1.36; 95% CI:1.27-1.46; *p*<.0001). Ecstasy use in past year was also significantly more likely among students who were male, white, underage, fraternity/sorority member, and in the northeast.

A Trend in Ecstasy Use at 10 High Binge Schools (Figure 1)

Figure 1 shows a trend in past year use rate of ecstasy and marijuana for a recent few years at 10 high binge schools. While past year marijuana use rate did not significantly change from 1997 to 2000 (38.5% vs. 37.6%, $p=0.5601$), past year use of ecstasy increased dramatically from 1997 to 2000 (4.7 % vs. 10.6%, $p<0.001$). The rise in MDMA use continued at 10 high binge schools between 1999 and 2000. Logistic regression revealed that students on 10 high binge campuses were 1.4 times more likely to use MDMA in 2000 than in 1999 even when controlled for age, gender, race/ethnicity, and region (Adjusted OR = 1.37; 95% CI: 1.17-1.61; $p=.0001$).

Behavioral and Lifestyle Factors Associated with Ecstasy Use (Table 3)

Table 3 presents the result of a multivariate logistic regression analysis examining students' lifestyle and behavioral factors associated with ecstasy use in past year. Students who used ecstasy in the past year were more likely to use marijuana, engage in binge drinking, smoke cigarettes, have more sexual partners, rate arts and parties as important, rate religion as less important, spend more time socializing with friends, and spend less time studying. The variable most strongly associated with ecstasy use was marijuana use in past year. 92.1% of students who used ecstasy in the past year also used marijuana. Students who used marijuana in past year were 13 times more likely to use ecstasy.

Discussion

Our data indicate that ecstasy use among college students is rising dramatically and continues to be a significant public health concern. In 1999, nearly five percent of college students reported that they had used MDMA in the previous year, a 69% increase from two years earlier. This increase was seen across nearly all subgroups of student and college type that were studied. A smaller sample of ten colleges studied in 2000 reveals a continuing trend.

These findings should concern policy-makers and college administrators alike; the upturn in use comes at a time when there is increasing evidence of potential short- and long-term medical and cognitive effects of ecstasy use. It also comes at a time when the use of other illicit drugs appears to have reached a plateau [34], suggesting that previously successful reduction efforts may not be effective with MDMA. Although the risks of ecstasy use are beginning to come to light in the popular media, there is an urgent need for increased and focused education.

As with other drugs, ecstasy is used by college students within a social context [19]. In contrast to non-users, MDMA users are more likely to spend large amounts of time socializing, attend a residential college, and belong to a fraternity or sorority.

Interestingly, although MDMA users are typical of other drug users in their tendency toward high risk behaviors (e.g. binge drinking, marijuana/cigarette use, and promiscuity) they do not conform completely to previous descriptions of college drug users [29, 35]. Even though ecstasy users spend less time studying, they may not represent academic underachievers since they do not differ from other students in grade point average. Similarly, although MDMA use is correlated with less importance placed on religion and more importance placed on parties, users are no different than non-users in the importance they place on community service and place more importance on the arts than non-users. This may suggest that traditional social alternatives to parties that are

offered on college campuses might be an even more effective approach to curbing ecstasy use. Within any program, however, stereotypes of “typical hard drug users” must be avoided, and a more mainstream, ambitious, and creative individual should be targeted.

It is unclear why ecstasy use is on the rise. The significant increases within each class suggest that there is not simply a cohort effect of high school users moving on to college. Certainly the positive reputation and novelty that MDMA has when compared to more traditional drugs is having an effect on overall use [36]. Whatever the cause of the increase, however, the findings of this study suggest that the first approach toward curbing use is a campaign to fully disseminate information concerning the significant risks associated with ecstasy use. That campaign should include physicians and educators in addition to popular media and begin at least during early adolescence.

The findings must be viewed in the context of certain limitations of the study. The study is based on self-reported responses to a mail survey, which might introduce sources of bias. One potential limitation is non-response bias. Although the survey response rate was 60%, the prevalence of other substance use did not differ between respondents and a sample of non-respondents. In order to control for potential non-response bias, we included college response rate as an independent variable in multivariate analyses. Furthermore, the increased rates of MDMA use are consistent with rates found in other national surveys [19]. The rise in annual rates of any other drug use reported by Johnston [19] was also similar to the rise in rates found in our study. Small discrepancies in rates may be attributed to the non-inclusion of 2-year colleges in our sample. Another potential limitation may be answers intentionally or unintentionally distorted by respondents. It has been widely accepted to use students’ self-report for assessment of drug use status because biochemical measures have established the validity of self-reports in national surveys [37-38]. Underreporting of ecstasy use is probably even less likely in this survey, which focused almost entirely on alcohol rather than drug use. The definition of ecstasy use in this study was “use within past 12 months”. Despite having collected data late in the academic year, all ecstasy uses might not have taken place in college. Even though it is possible that some of the incoming freshmen may use it during the end of their high school career, our data showed that the increase rate held regardless of year in school.

Despite these limitations, it is evident that MDMA use among United States 4-year college students is on the rise while other illicit drug use has remained constant, and behavior and lifestyle of ecstasy users are different from those of other illicit drug users. These findings suggest that special attention needs to be provided to developing effective prevention programs to decrease ecstasy use.

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Figure 1. Used Ecstasy or Marijuana in past year at ten high-binge schools

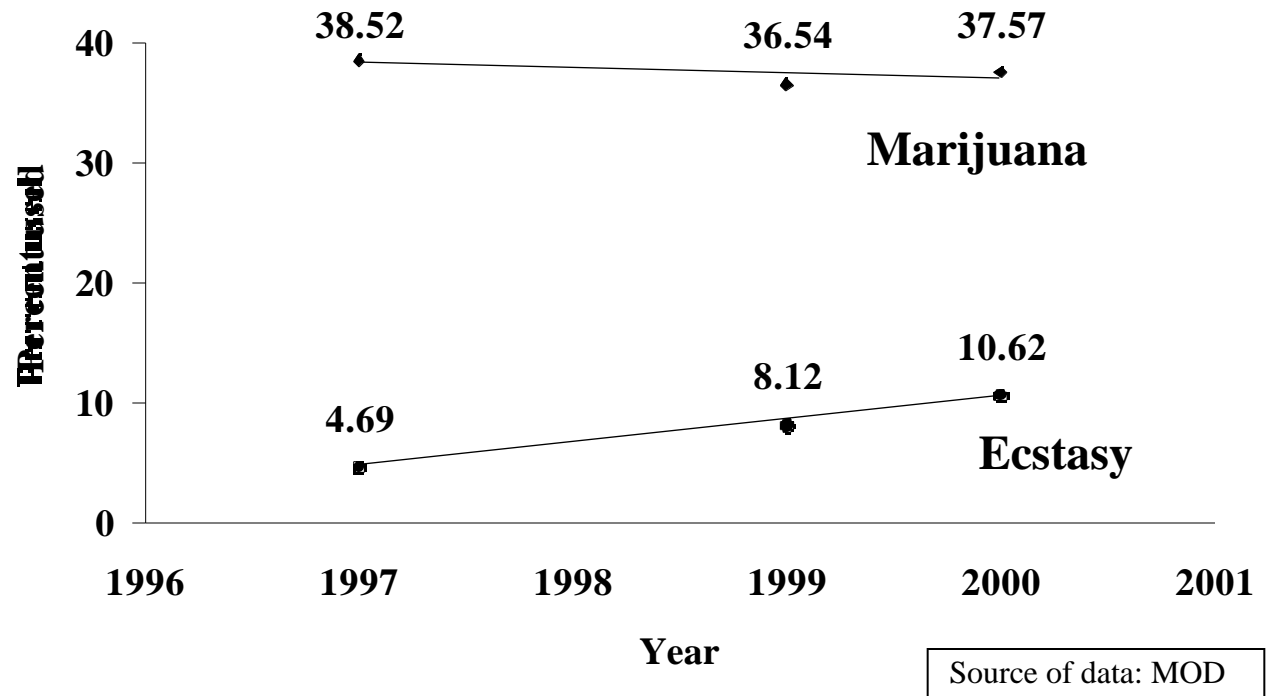


Table 1. Changes in Prevalence of Past Year Ecstasy Use by Student Characteristics, 1997 to 1999

Characteristic	% past year Ecstasy use		% change	Chi-square p-value
	1997 (n=14,657)^	1999 (n=13,958)^		
All students	2.80	4.73	68.9	<.0001
Gender				
Male	2.98	5.28	77.2	<.0001
Female	2.68	4.39	63.8	<.0001
Ethnicity				
White	2.98	5.16	73.2	<.0001
African American	0.82	0.75	-8.5	0.8738
Asian/Pacific Islander	1.92	3.91	103.6	0.0057
Other	3.11	4.34	39.5	0.0866
Hispanic				
Yes	3.03	3.67	21.1	0.4122
No	2.77	4.83	74.4	<.0001
Age (years)				
<21	3.27	5.80	77.4	<.0001
21- 23	2.82	4.35	54.3	<.0001
> 24	1.38	2.08	50.7	0.0698
Marital Status				
Never married	3.00	5.15	71.7	<.0001
Married	1.03	0.75	-27.2	0.4224
Year in school				
Freshman	2.94	5.12	74.1	<.0001
Sophomore	2.86	5.79	102.4	<.0001
Junior	3.36	4.67	39.0	0.0059
Senior	2.24	3.84	71.4	0.0002
Residence				
Dormitory	2.49	4.97	99.6	<.0001
Fraternity/sorority house	4.52	5.72	26.5	0.4511
Off campus	2.96	4.78	61.5	<.0001
Fraternity/sorority member	3.62	6.03	66.6	0.0004

^ Because of missing responses, non-responding students were excluded from analysis. Sample size may vary slightly because of missing responses to questions regarding student characteristics and past year ecstasy use.
n=number of students.

Table 2. Changes in Prevalence of Past Year Ecstasy Use by College Characteristics, 1997 to 1999

Characteristic (N=119)	N		% past year ecstasy use		%Change	Chi-square p-value
	1997	1999	1997	1999		
Religious affiliation	19	19	2.37	4.49	89.5	<.0001
Non-religious	100	100	2.89	4.77	65.1	<.0001
Small <5,000	35	40	2.03	4.59	126.1	<.0001
Medium 5,001--10,000	23	27	3.14	4.54	44.6	0.0050
Large > 10,000	61	52	3.12	4.92	57.7	<.0001
Not competitive ^	29	25	2.06	2.51	21.8	0.2265
Competitive	48	43	3.00	4.35	45.0	0.0002
Very competitive	27	29	3.39	6.58	94.1	<.0001
Highly competitive	14	21	2.19	5.31	142.5	<.0001
Commuter school #	18	17	1.84	3.44	87.0	0.0016
Not commuter school	101	102	2.96	4.93	66.6	<.0001
Northeast	28	28	3.71	8.37	125.6	<.0001
South	35	35	3.05	4.53	48.5	0.0005
North central	35	35	1.53	2.22	45.1	0.0170
West	21	21	3.42	4.83	41.2	0.0101
Women only	6	6	1.88	4.45	136.7	0.0036
Co-educational	113	113	2.85	4.74	66.3	<.0001
Public school	82	82	2.81	4.38	55.9	<.0001
Private school	37	37	2.78	5.52	98.6	<.0001
Suburban/Urban	79	85	2.73	4.88	78.8	<.0001
Rural/Small town	40	34	2.93	4.36	48.8	0.0002
Low binge campus ##	37	31	2.17	3.06	41.0	0.0071
Medium binge campus	50	50	3.08	4.16	35.1	0.0036
High binge campus	32	38	3.17	6.72	112.0	<.0001

N = number of schools.

^ Competitiveness was based on standardized test scores and percentage of applicants accepted as reported in Barron's Profiles of American Colleges.³⁷

Commuter schools were defined as schools with > 90% of students living off campus.

Schools were divided into three groups on the basis of their aggregate rates of binge drinking: low binge \leq 35%, medium binge 36% - 50%, high binge > 50%.

Table 3. Behavioral and Lifestyle Factors Associated with Past Year Use of Ecstasy: A Multiple Logistic Regression Analysis fitted by GEE

Factor	Adjusted OR	(95% CI)	p-value
Risky Behaviors			
Binge Drinking	1.37	(1.02-1.84)	0.0344
Past Year Marijuana Use	12.78	(8.86-18.42)	<.0001
Past Year Cigarettes Use	1.75	(1.41-2.17)	<.0001
>2 Sex Partners in Past Month	1.69	(1.24-2.31)	0.0009
Education			
>B Grade Point Average	0.89	(0.74-1.08)	0.2482
Satisfied with education	1.05	(0.70-1.57)	0.8236
Participation is important			
Arts	1.56	(1.29-1.88)	<.0001
Parties	1.46	(1.18-1.80)	0.0005
Community Service	0.88	(0.72-1.07)	0.2079
Religion	0.70	(0.55-0.89)	0.0039
Spends >2 hours per day			
Studying outside of class	0.78	(0.62-0.98)	0.0297
Socializing with friends	1.49	(1.21-1.84)	0.0002

Analysis limited to 1999 survey data.

The model also included gender, age, marital status, race, region, school binge level, and college response rate.

The results for these variables were not shown.

OR=Odds ratio, CI=Confidence interval.

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